

Frequency Filtering

At the end of this Session, you will be able to:

- **Define the term filter.**
- **List the uses of frequency filters.**
- **Describe the parameters used to define a filter .**
- **Define the term ringing and describe how it occurs.**
- **Define the terms slope, dB and octave.**
- **Define the terms high-cut filter, low-cut filter, bandpass filter and notch filter.**
- **Define the terms space variant filter and time variant filter.**

Filter

The definition of a filter is a part of a system that discriminates against some of the information entering it. What we going to deal with are frequency filters. Which discriminate against certain frequencies.

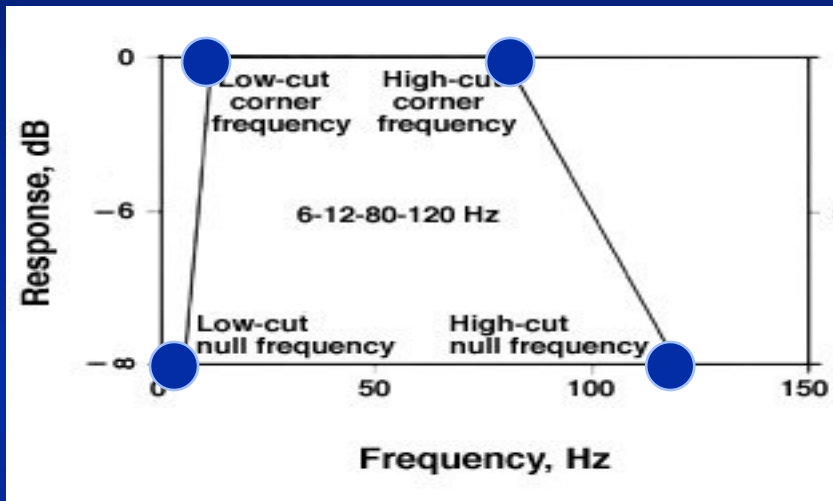
So why would we want to discriminate against certain frequencies (ie allowing some to pass untouched and removing others)

Noise removal filters

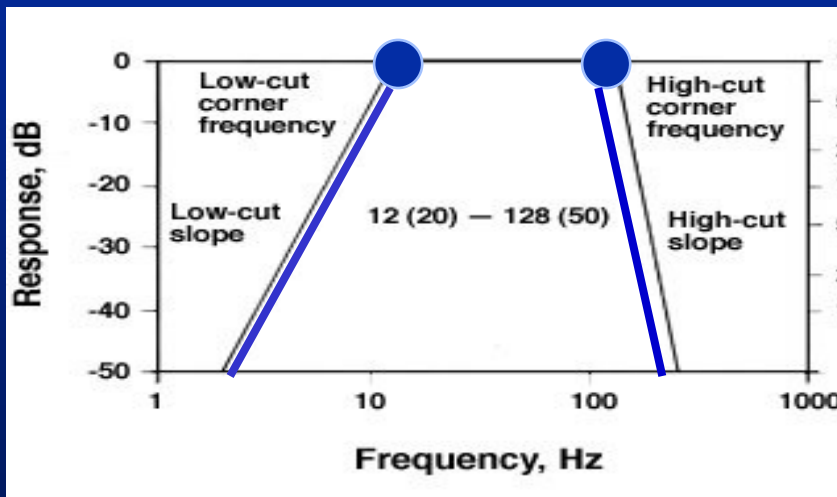
Anti-alias filters

Filter Parameters

Parameters can be defined in 2 different ways



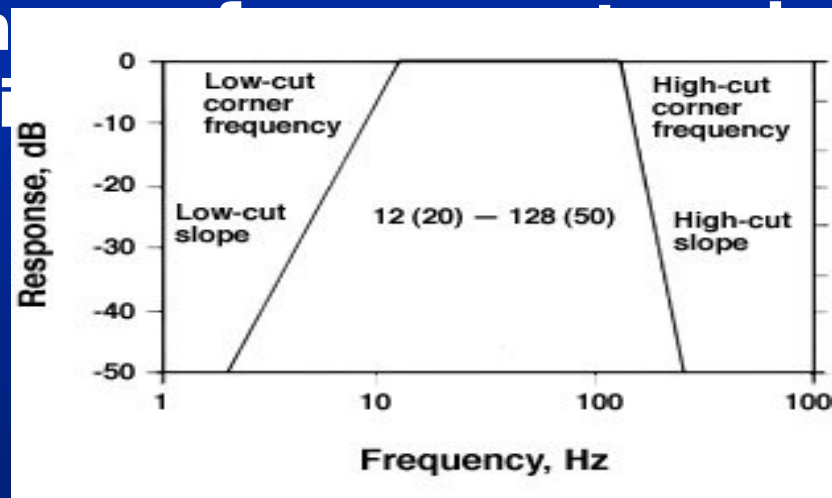
You can specify the four corner points of the filter.



You can specify the high and low cut corner points and slopes.

Ringing

Ringing is an oscillatory effect caused by having steep sides on our filter. You should never create a filter where at one frequency you are allowing all energy to pass untouched and at the next frequency removing all energy. You should have a gradual change in energy at the cut-off frequency. This is done by specifying



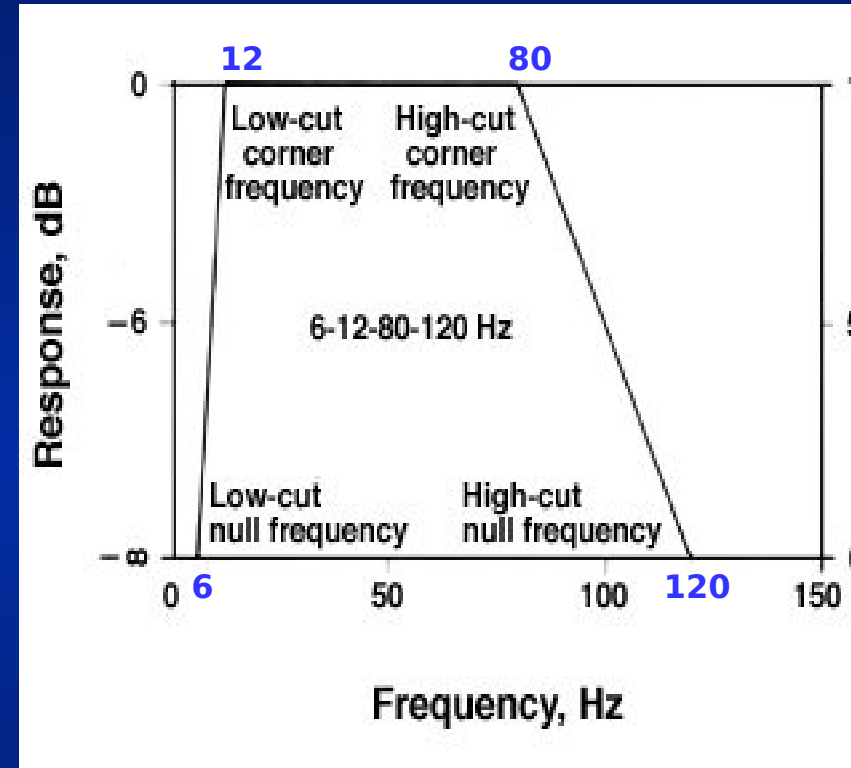
Recommended filter slope values to use are **18 dB / Octave** for the low frequency slope and **72 dB / Octave** for the high frequency slope.

Filter Parameters

Specifying the four corner points in the picture opposite:

Frequencies below 6Hz and above 120Hz will be zero'd. While frequencies between the 12Hz and the 80Hz will be untouched.

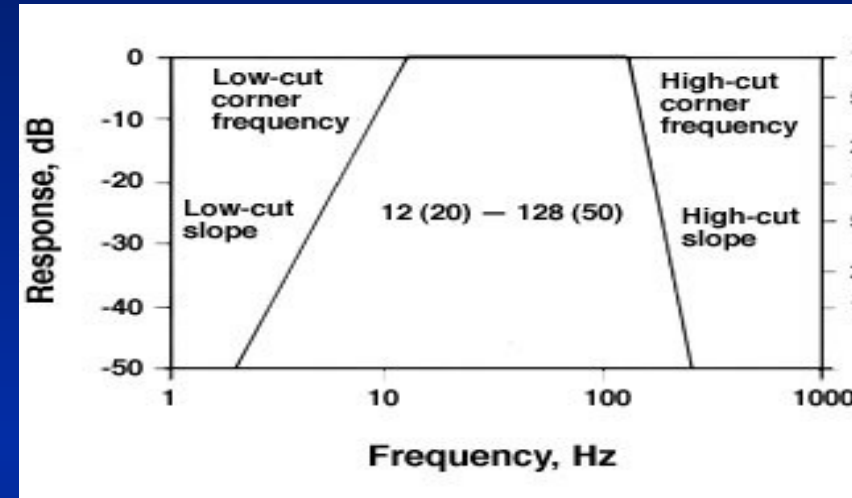
Frequencies between 6Hz and 12 Hz will have their amplitudes reduced and the same with frequencies between 80Hz and 120Hz



Filter Parameters

Specifying the low-cut corner frequency, high-cut corner frequency and slope in the picture opposite:

Frequencies between the 12Hz and 128Hz will be untouched.



The slope on the low-cut side is 20dB/Octave and on the high-cut side is 20dB/Octave.

What's dB?

What's Octave?

dB

A decibel is a unit used in expressing amplitude ratios.

So we can use the decibel scale to specify how much we would like the amplitude of our frequencies to be reduced by.

So if you specify an amplitude reduction of 6dB that means you are going to half your amplitudes for that frequency.

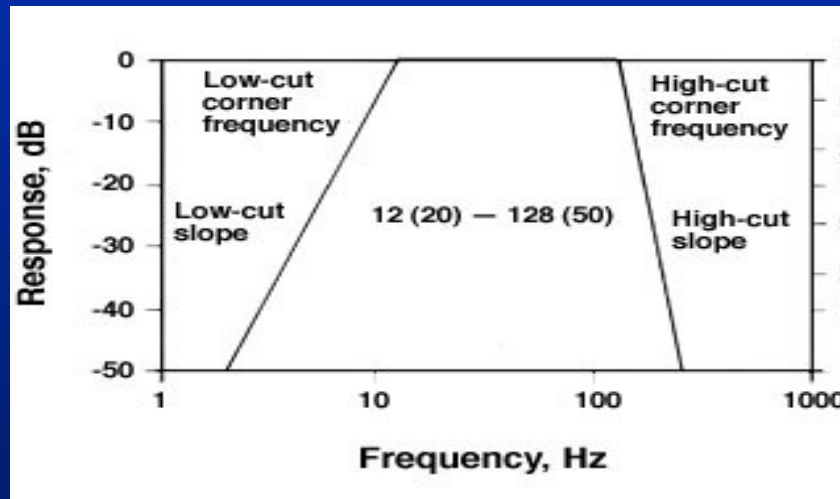
So we've specified the amplitude part of the slope now we need to specify the frequency part

<u>dB</u>		<u>Ratio</u>
3dB	⇒	1.4 :
6dB	⇒	1 2 :
10dB	⇒	3 :
12dB	⇒	4 :
20dB	⇒	10 :
40dB	⇒	100:1
60dB	⇒	1000:1

Octave

An Octave is a unit used in expressing frequency ratios.

The only ratio we need to remember is that 1 octave represents a 2:1 frequency ratio.
So what does a slope of 6dB per Octave mean?



So in the filter opposite how much will the amplitudes be reduced by at 6Hz **A Factor of 10**

Definitions related to filters

- **Bandwidth** - frequency range within a signal/filter
- **Bandpass filter** - passes a specific bandwidth only
- **Lo-cut (high pass) filter** - attenuates frequencies below specified value
- **Hi-cut (low pass) filter** - attenuates frequencies above specified value
- **Notch filter** - attenuates frequency(ies) at specified values
- **Anti-alias filter** - attenuates frequencies prior to sampling which would otherwise alias at that sample rate
- **Ringling (reverberation)** - oscillatory effect produced by narrow-band filters or steep cut-off slopes
- **Space and time variance** - filters which have different characteristics dependent on position in space and time

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